

Acute Metallosis Following Total Knee Replacement – A Case Report

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What to Learn from this Article?

Metallosis after Hip Replacement is a known phenomenon but metallosis after knee replacement is quite rare

Abstract

Introduction: Metallosis involving the knee joint most often results from metal-on-metal contact late in the life of a failing implant following polyethylene wear. We report a case of acute metallosis following knee arthroplasty in a previously healthy 59-year old male.

Case Report: In June 2011, the patient underwent left knee arthroplasty for severe osteoarthritis with necrosis and bone edema in the medial femoral condyle and tibial plateau. Nine months later, because of persistent pain and swelling in the joint, revision arthroplasty was undertaken along with partial synovectomy. Examination revealed pristine prosthetic implants in the absence of loose fragments of bone or glue. Synovial pathology exhibited marked chronic inflammation and hyperplasia with extensive finely granular foreign material resembling metallic debris. Laboratory analysis of synovium revealed a predominance of iron, the principal component of the saw blades.

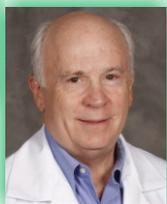
Conclusion: We hypothesize the patient experienced acute metallosis resulting from deposition of metallic fragments from three saw blades used during arthroplasty. We believe the increased density of the patient's bone that required use of multiple blades may have resulted, in part, from heavy lifting the patient partook in during the two years preceding arthroplasty.

Keywords: metallosis; knee arthroplasty; saw blades.

Author's Photo Gallery



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Introduction

Metallosis involving the knee joint most often results from metal-on-metal contact late in the life of a failing implant following polyethylene wear (1 - 3). The metallic components may come into contact at the tibio-femoral or patella-femoral interface with metal-backed patellar components (2). We report a case of metallosis following knee arthroplasty in which synovitis developed acutely after joint replacement, most likely as a result of deposition of metallic debris from oscillating bone saw blades.

Case Report

On March 18, 2011, a healthy 59-year-old male was diagnosed with left knee osteoarthritis by arthroscopy; no abnormalities of the synovium were detected at this time. On June 27, 2011, the patient underwent left knee arthroplasty for severe osteoarthritis with necrosis and bone edema in the medial femoral condyle and tibial plateau. A hemipatelectomy was undertaken along with transection of the femur and tibia which, because of density of bone, required the use of three saw blades (Brasseler USA, blade number KM71-563) using a Conmed Linvatec motor. Total knee replacement was undertaken using an 83 mm tibial tray with a 75 mm femur (Biomet), a large patella and a 12 mm spacer. Four liters of saline were used to flush the joint during the procedure. A pre-operative varus deformity of the knee was corrected

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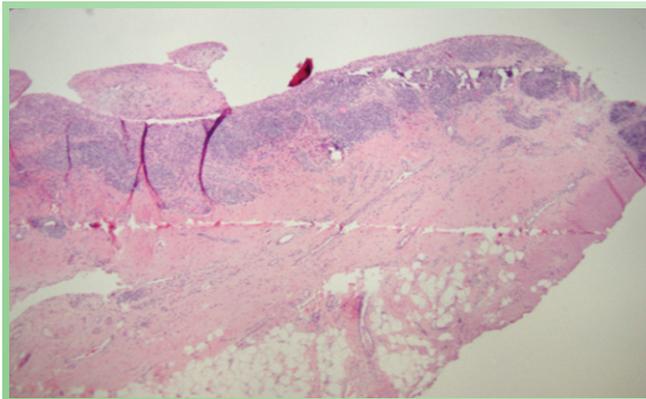


Figure 1: Lymphoid infiltrate and synovial lining cells in 59 year old male with acute-onset metallosis following total knee replacement (hematoxylin-eosin x100).

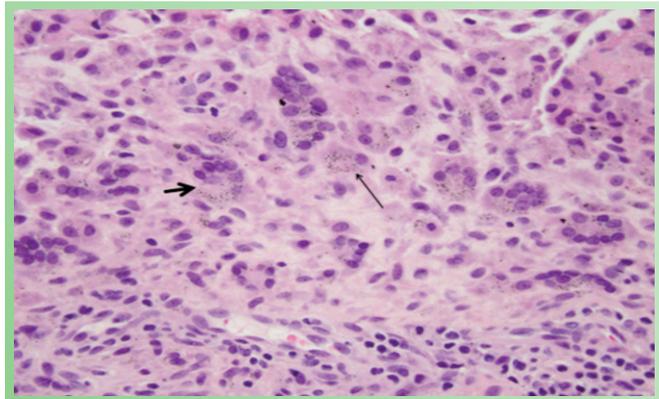


Figure 2: Intracellular metallic debris in synovial lining cells (thin arrow) and giant cells (thick arrow) in 59 year old male with acute-onset metallosis following total knee replacement (hematoxylin-eosin x 1000).

with an absolute neutral position after insertion of the implant.

Because of persistent swelling, decreased range of motion, and joint pain following months of intensive physical therapy with icing and treatment with non-steroidal anti-inflammatory agents, on March 22, 2012 the patient underwent revision arthroplasty with partial synovectomy (discolored, brown-tan portion removed) and exchange of the spacer from 12mm to 14mm. A radiograph of the knee prior to the procedure did not reveal the metal-line sign. Aspiration of the joint produced clear yellow fluid that yielded no growth on culture. Inspection revealed pristine

prosthetic implants and the absence of loose fragments of bone or glue. The joint exhibited full range of motion without tendency toward subluxation, and the patella tracked down the midline with good stability in extension and without lift off in flexion. After irrigation of the joint with nine liters of saline with antibiotic solution, the wound was closed.

On pathologic examination, the synovium exhibited marked chronic inflammation and hyperplasia with extensive finely granular foreign material resembling metallic debris (Figs 1 and 2). Laboratory analysis of synovial tissue for iron, chromium, and cobalt demonstrated the presence of each metal at the following levels: iron (150 micrograms/gram), chromium (17 micrograms/gram), and cobalt (14 micrograms/gram). Although reference ranges for these metals in synovium are not established, normal tissue levels of chromium and cobalt should be undetectable; iron would be detectable in tissue with hemorrhage, but the synovium did not show evidence of significant hemorrhage.

In June of 2013, the patient was found to have the following blood metal results: serum iron, 141 micrograms/deciliter (reference range, 40 – 155); plasma chromium, 2.6 micrograms/deciliter (reference range, 0.1 – 2.1); and plasma cobalt, 1.7 micrograms/deciliter (reference range, 0 – 0.9). To determine the likely origin of the synovial metals, we investigated the composition of the prostheses, cutting block, and saw blades (table).

Discussion

Early onset metallosis following total knee replacement is rarely described. In one report (2), 14 patients developed metallosis within two years of receiving a dual-coated uncemented femoral component from which alumina ceramic particles may have dislodged from an overlying layer of hydroxyapatite. Revision surgery was undertaken between seven and 32 months after the initial operation in all 14

Table. Chemical composition (expressed in percents) of saw blades, prostheses, and cutting block used during total knee replacement in a 59-year-old male¹.

Metal	Component		
	Saw blade ²	Prostheses ³	Cutting block ⁴
Aluminum	0.10	-	-
Boron	0.10	-	-
Carbon	0.38	0.35	0.07
Chromium	13.53	30.00	17.50
Cobalt	58.53	-	-
Iron	75.06	0.75	74.91
Manganese	0.59	1.00	1.00
Molybdenum	0.91	7.00	-
Nickel	0.12	0.50	5.00
Niobium + Tantalum	-	0.45	-
Nitrogen	0.25	-	-
Phosphorus	0.02	0.02	0.04
Silicon	0.39	1.00	1.00
Sulfur	0.00	0.10	0.03
Titanium	0.10	-	-
Tungsten	0.20	-	-

1	Patellar component, 100% polyethylene; spacer, 100% polyethylene with titanium pin
2	Brasseler blade number KM71-563 (large bone oscillating blade)
3	Biomet item numbers: tibial plate - #141236; femur - #183184
4	Biomet 4-in-1cutting block

patients, and the retrieved implants showed deep scratching to the naked eye.

The novelty of the present case is the early onset of synovitis in a patient who exhibited pristine implants nine months after initial surgery. We believe metallosis developed acutely following deposition of iron from the three saw blades used during surgery, and that these fragments were not dislodged entirely by four liters of saline irrigation. A diagnosis of metallosis was supported by findings on pathology of finely granular foreign material resembling metallic debris in the synovium, and on laboratory analysis, the principal metal detected was iron.

Several factors support the saw blades as the source of synovial iron. First, in over twenty years of performing knee replacement surgery, this was the first arthroplasty in which the surgeon required the use of three blades. Although we cannot exclude the cutting block as an additional source of iron, the fact that the same model had been used for years without evidence of debris deposition argues against this possibility. Finally, the tibial and femoral implants were unlikely to be the source of iron given iron comprised <1% of the implants. The minute amounts of synovial chromium and cobalt may have derived from the prostheses as a result of metallosis-induced inflammation. Cobalt-chromium particles have a high specific surface area that promotes dissolution of these metal ions into surrounding tissues (4). After phagocytosis by macrophages, the ions are transported to lysosomes, which, in turn, release the metal ions into peri-prosthetic tissues following apoptosis and necrosis of the phagocytosing cells (4).

Although subchondral bone density is known to increase during the course of osteoarthritis of the knee (5), we hypothesize that a unique activity undertaken by the patient during the two years prior to arthroplasty may have significantly increased bone density. Specifically, after purchasing a wood stove, the patient began lifting heavy logs prior to splitting them into firewood. The heaviest logs were estimated to weigh as much as 150 pounds. It is possible that repeated lifting over two years contributed to cartilage loss and subchondral bone compression. Indeed, the patient reported an accelerated worsening of symptoms of osteoarthritis following purchase of the wood stove and the attendant wood-lifting activities that followed.

Conclusion

Recognizing that bone cutting blades may differ in hardness, we believe it is important that surgeons have ready access to comparative ratings of blades in terms of hardness. Such information may inform surgeons in their choice of blades prior to, or even during, surgery should they encounter patients with unusually dense bone, mitigating, thereby, the need for multiple blades with the consequent risk of irretrievable debris deposition.

Clinical Message

We believe the clinical features described herein represent a case of acute metallosis following knee arthroplasty, a condition that has not been reported heretofore.

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